GET2026
7TH EAGE GLOBAL ENERGY TRANSITION CONFERENCE & EXHIBITION

GET2026 CRITICAL RAW MATERIALS SYMPOSIUM

CRMsDataSpace RFCS PROJECT

CRMsDataSpace: Turning Europe's Coal-Mining Legacy into Shared Intelligence for Critical Raw Materials

Hernan Flores
German pilot lead
Land Use & Transition, Research Center of Post-Mining, THGA, Bochum

Technische Hochschule Georg Agricola University

From mine-waste management to CRM assessment

Resource assessment builds on environmental safeguards

WE ARE HERE

2006 — Environmental protection

Extractive Waste Directive (2006/21/EC)

2019 — Recovery experience



2024 — CRM recovery assessment



2026 — Expanding the evidence base

European databases already available; improving coverage, characterisation and comparability.

2027 onward — Project decisions

Further assessment & project decisions

CRMsDataSpace 2025–2028

Coal-related sites: integrated, traceable evidence to support assessment

Sources: Directive 2006/21/EC, Arts. 5 & 20; JRC (2019); Regulation (EU) 2024/1252, Art. 27; MIN4EU / EGDI (2026)

Coal mines close – the waste stays

Closure ends production, not responsibility



Coal Spoil Heap in, Silesia, Poland

Production declines. The waste remains.

1. **Mine dumps**
   Overburden and waste rock
2. **Tailings**
   Fine-grained residues from coal processing
3. **Mine-water sludges**
   Solids from water treatment

Long-term environmental liabilities – and possible secondary sources of critical raw materials, to be assessed site by site

Sources: Kinnunen (2019); EU Parliament (2019)

Earth observation sees the surface – assessment needs more

Mine-waste facilities are a good EO target, but EO is one line of evidence among several

What EO can contribute

- Extent and geometry of dumps, ponds and heaps
- Change over time (repeat acquisitions)
- Ground deformation, e.g. InSAR time series
- Surface and spectral signatures (satellite, UAV hyperspectral)
- Vegetation, moisture and water context

What it cannot establish alone

- Volume and composition below the surface
- Grade and mineralogy at depth
- Particle-size and metal distribution
- Process performance and recovery
- Resource classification (e.g. UNFC)

→ **EO, field sampling, laboratory data and legacy records need to sit in one comparable frame.**

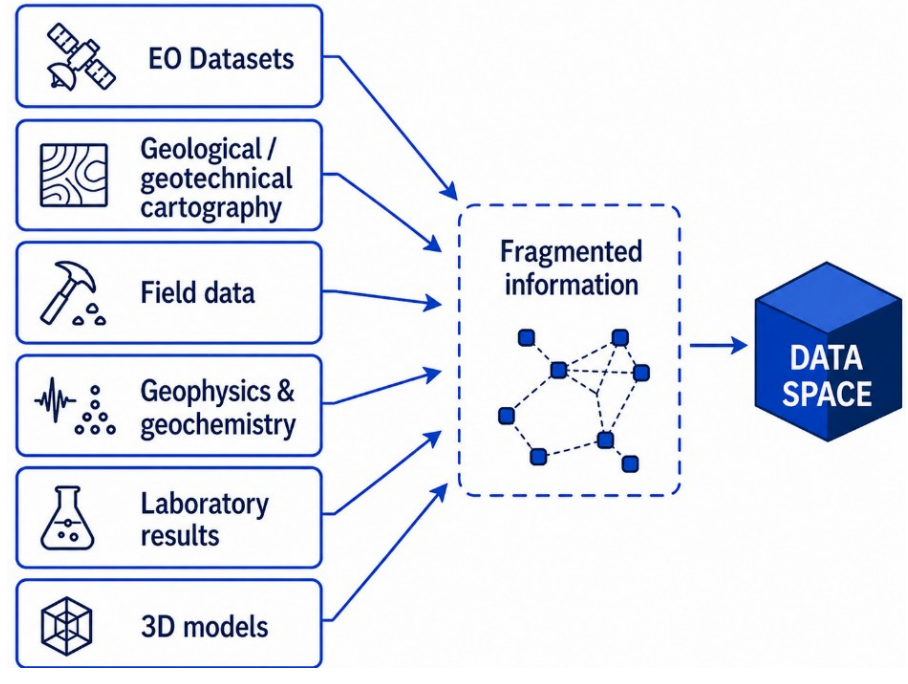
The CRMsDataSpace solution

A Data Space is needed to turn scattered datasets into comparable, decision-ready information.

Site comparison
Compare sites across different formats, scales, and terminology

Evidence integration
Combine EO, field data, laboratory analyses, and legacy records.

Decision support
Translate observations into CRM assessment indicators.

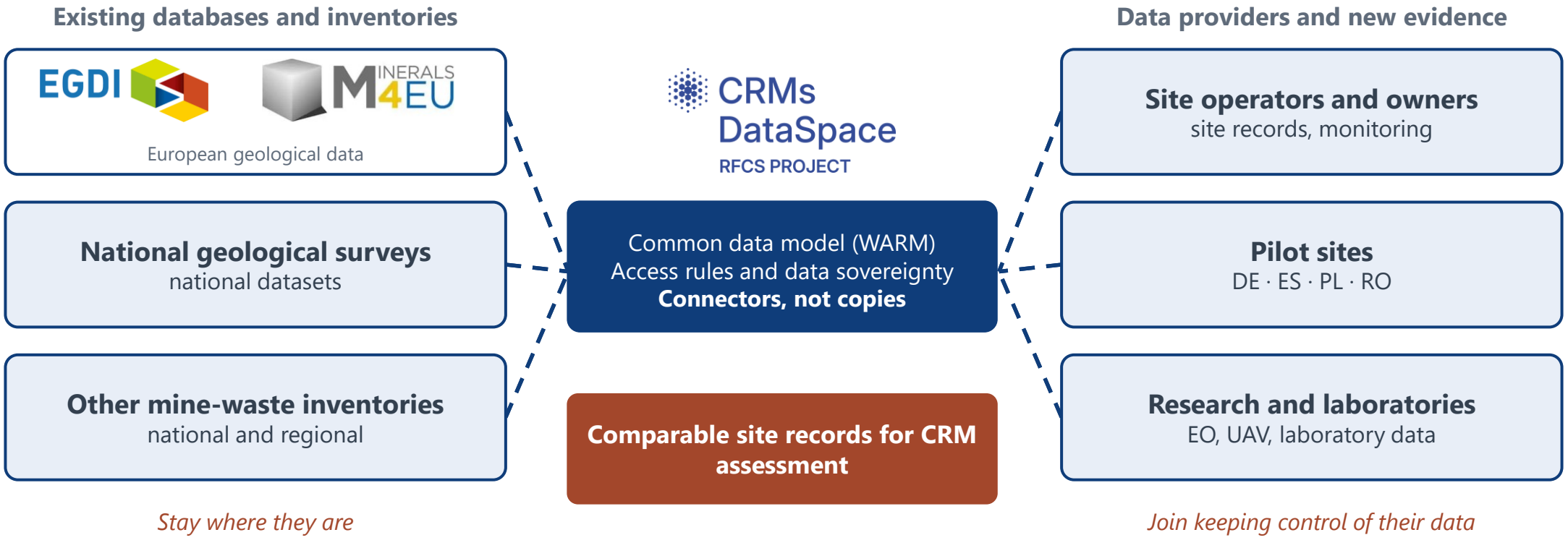


RFCS project · 2025–2028 | **Grant Agreement 101216677** | **Coordinated by GIG-PIB (PL)** | **Partners in 5 countries**

Source: Flores, et al. 2026

Where the data space fits: connecting, not replacing

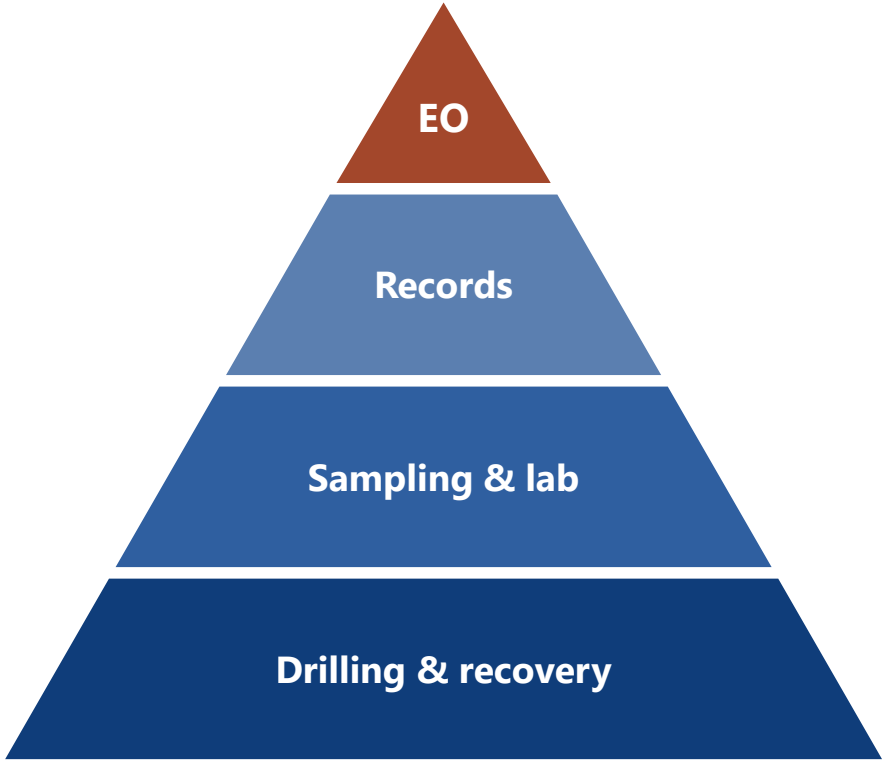
A federated layer on top of existing European sources – data stay with their owners



Interoperability by design: WARM follows INSPIRE and is aligned with EGDI; specific connections to be defined with each source.

WARM – Waste As a Resource Model: from EO screening to site detail

One site record that fills in as evidence moves from broad screening to detailed assessment



↓ *more detail, fewer sites*

What it gives	Fills in WARM
EO screening All sites: extent, change, surface signatures	**Facility and location**
Existing records Inventories, history, monitoring	**Geological and site context**
Field sampling and laboratory Composition and mineralogy	**Fieldwork, samples, analyses**
Drilling and recovery tests Selected sites, where applicable	**Resources (UNFC)**

Making sites comparable: the WARM data model

Making distributed data uniform and comparable

Facility identifier

MS – ISFT – NUTS3 – SN

e.g. ES-W-ES120-0001 · Member State, facility type, NUTS3 region, serial number

UNFC as the common language

E (economic) – F (feasibility) – G (geological knowledge), with the UNECE Supplementary Specifications for Anthropogenic Resources.

- Built on INSPIRE themes: Geology, Mineral Resources, Hydrography, Natural Risk Zones
- ISO 19100 / 19115 metadata; aligned with EGDI
- One record structure for dumps, tailings and mine-water sludges
- Reserved category for additional geospatial coverage (incl. UAV data)
- Designed so that EO-derived layers can carry provenance and uncertainty

Sources: CRMsDataSpace WARM data model; INSPIRE; EGDI; UNECE ECE/ENERGY/GE.3/2025/8

AI support for UNFC: useful for evidence extraction, not final classification

Preliminary benchmark of three open LLMs on three known deposits

G Geological knowledge

Evidence is often available in technical documents

Highest automation potential

F Technical feasibility

Requires project-specific information

Human review required

E Economic viability

Depends on economic and societal conditions

Expert judgement essential

Guardrail: the model answers “I don’t know” when the source does not provide sufficient evidence.

AI can structure evidence for the UNFC axes. Experts remain responsible for classification.

Sources: UNFC (UNECE); CRMsDataSpace WP6, University of Burgos

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Demonstration sites / pilot cases



Germany – Ibbenbüren, NRW
Mine-water sludge ponds





Poland – Libiąż, Lesser Poland
Coal waste dump



Spain – San Nicolás, Asturias
Coal waste dump



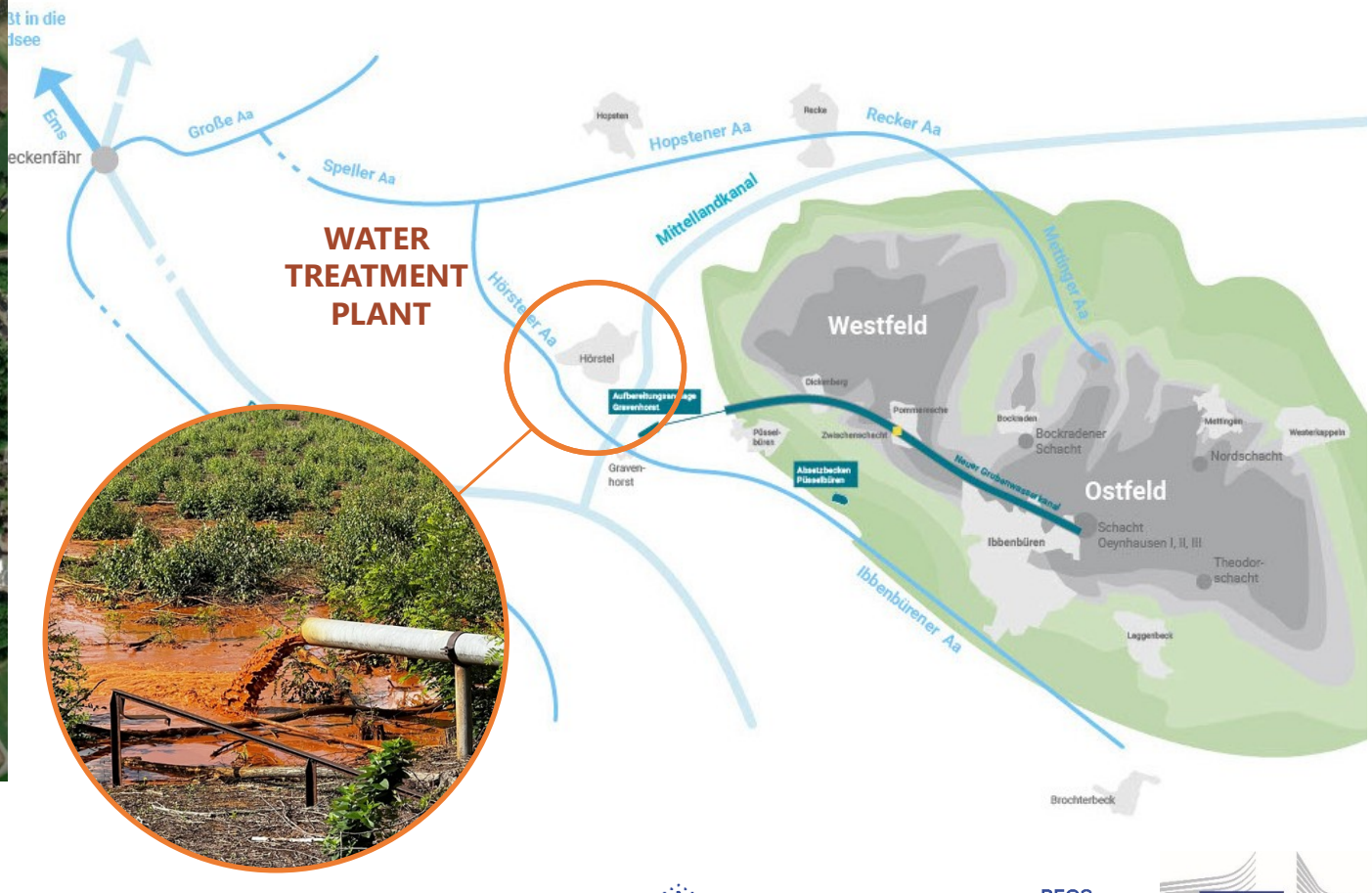
Romania – Petrila, Jiu Valley
Coal waste dump

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Ibbenbüren 1/4 – the site and its five sludge ponds

Five ponds filled with mine-water treatment sludge since the early 1980s

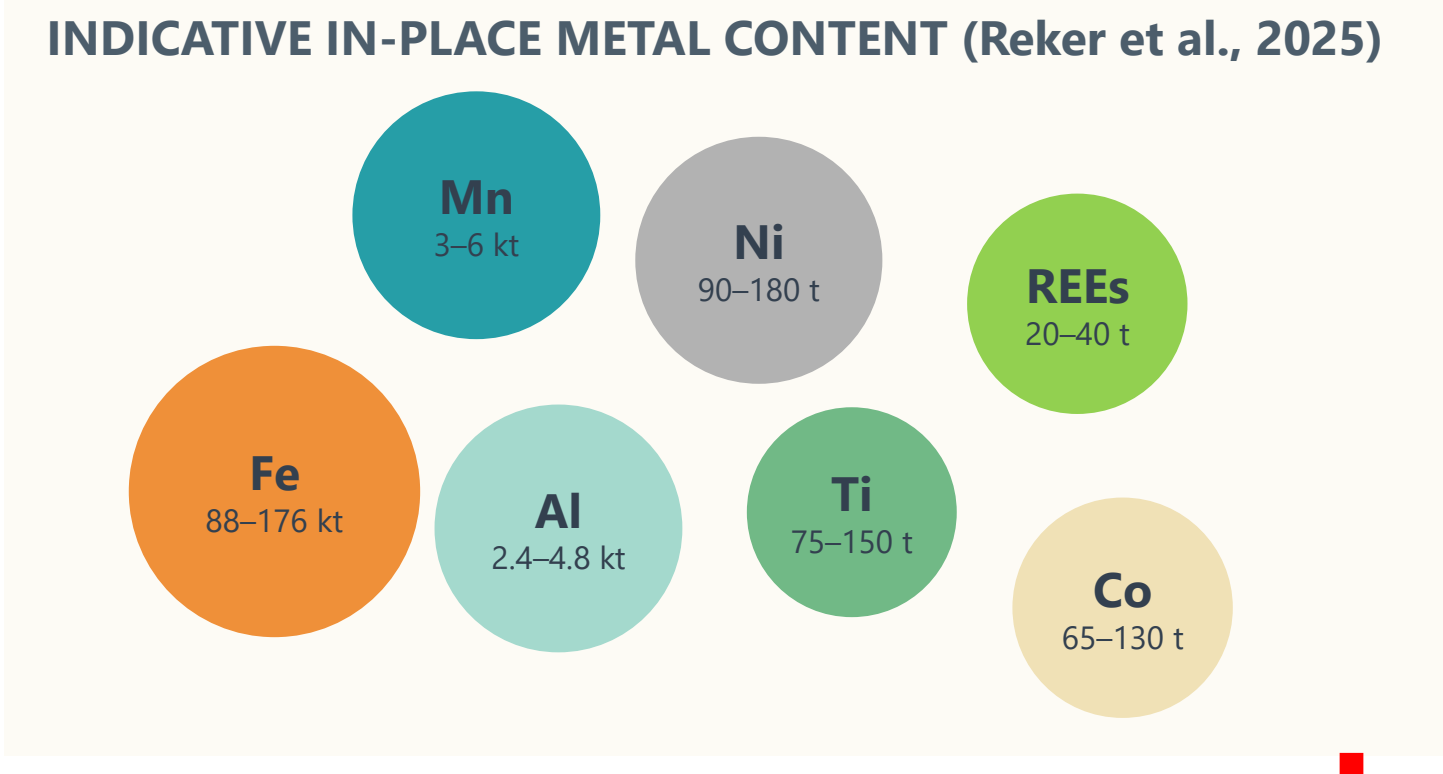




Ibbenbüren 2/4 – what earlier estimates say

Indicative in-place content, with ranges spanning a factor of two



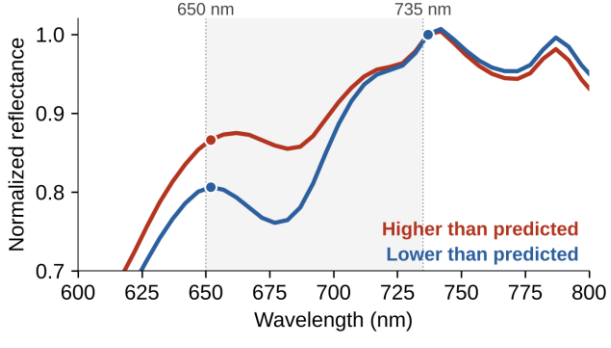


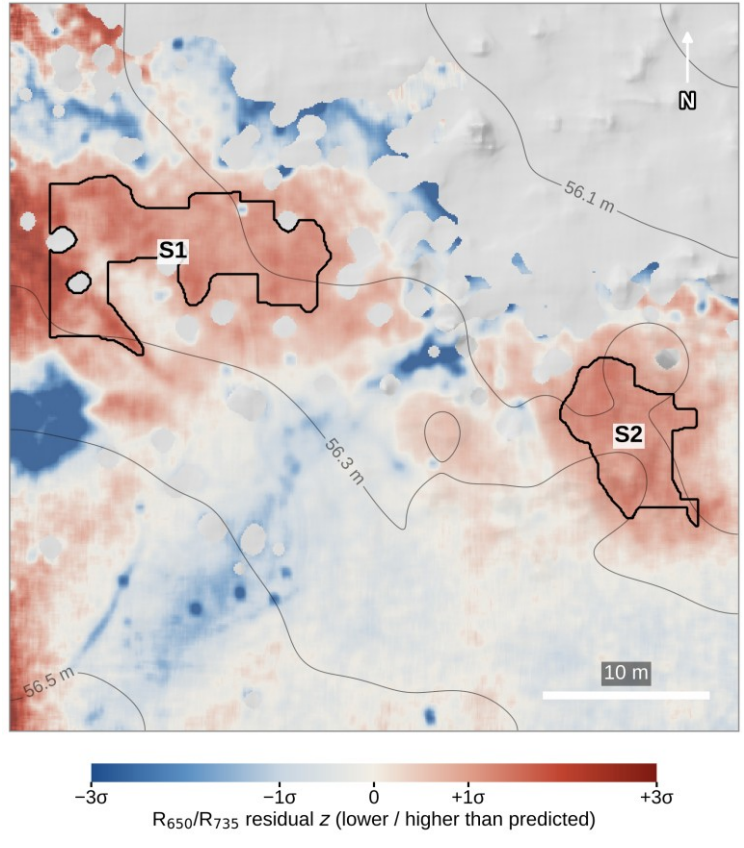
estimated content, not a demonstrated resource;
recovery to be tested !

Ibbenbüren 3/4 – UAV hyperspectral: where to sample

To narrow the factor-of-two range, we first need to know where to sample







1. **Image the surface**
2. **Find the highest signal**
3. **Target the sampling**

EO targets the sampling; lab data calibrate the EO

Sources: Flores et al. (2024), IMWA 2024; Flores PhD Thesis 2026

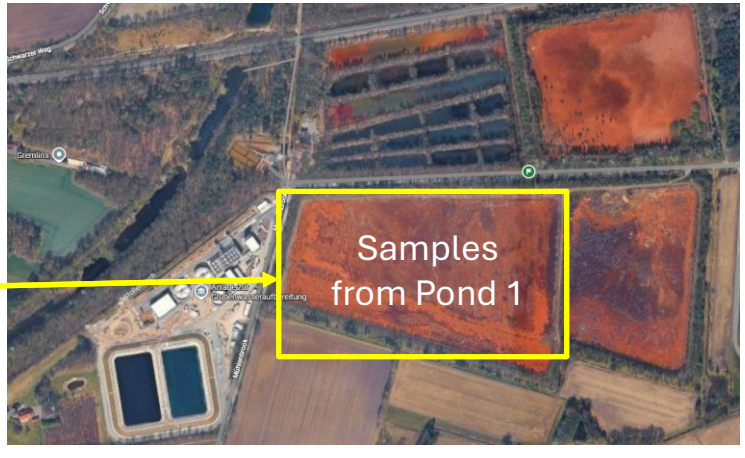
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Ibbenbüren 4/4 – laboratory: what can be recovered?

From indicative estimates to measured evidence



June 2026





4 composite samples approx. 69 kg

Samples currently being analysed in Katowice, Poland

Beneficiation

Physical separation methods, including particle-size, gravimetric, magnetic and flotation processes, are being applied to concentrate valuable fractions.

REE Recovery

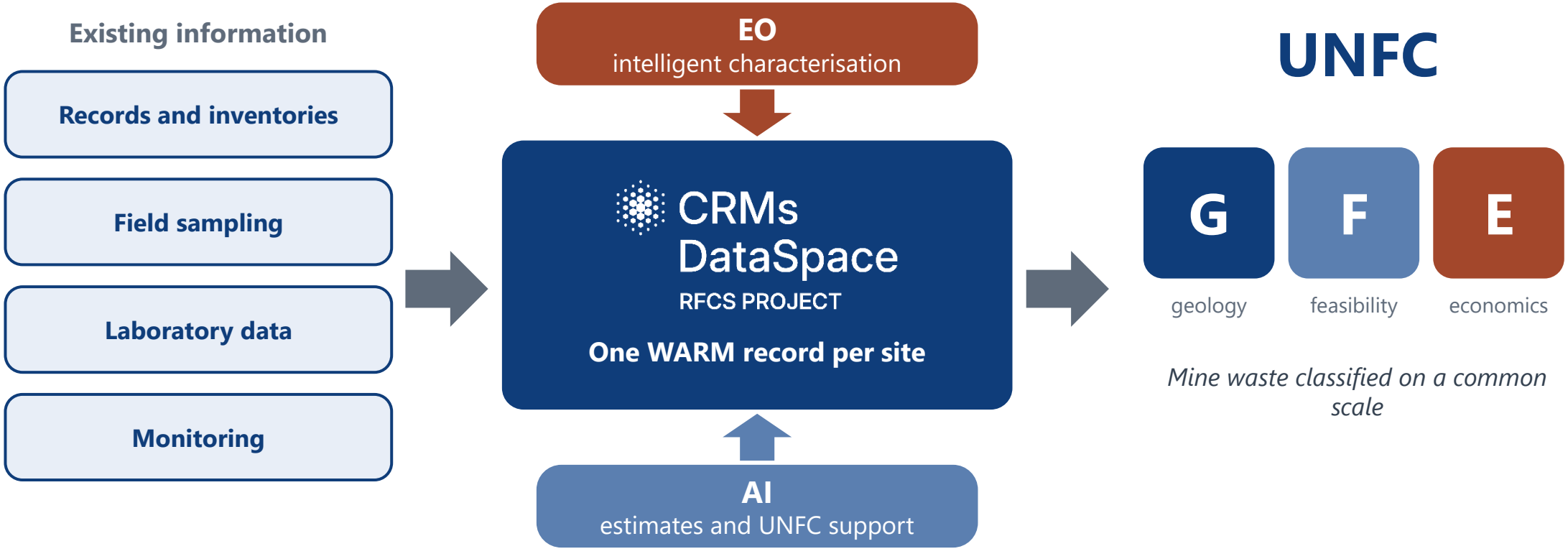
The resulting fractions will be further processed using hydrometallurgical methods to assess the recovery potential of rare earth elements.

Narrowing a factor-of-two range into usable evidence.

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From mine waste to UNFC

Existing information, seen together in the data space – supported by EO and AI



Data products · Screening methods · Validation: where the EO and AI community can contribute

Key take-aways

1 **Mine waste is a resource question, not only a liability**
Closed coal-mining sites deserve site-by-site assessment.

2 **EO tells us where to look**
Laboratory data tell us what is there and what can be recovered.

3 **A shared data space makes evidence comparable**
One WARM record per site, leading to UNFC.

How do we make metal production in Europe operational – and how can technology help us get there?

Thank you!

Hernan Flores
hernan.flores@thga.de
Research Center of Post-Mining, Bochum, Germany

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